

## OBSERVATIONS ON THE GENUS *VAUCHERIA* (XANTHOPHYCEAE, VAUCHERIALES) FROM THE GULF OF MEXICO

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**ABSTRACT** Investigations of algal mats from several locations along the Gulf of Mexico from Cameron Parish, Louisiana, to Manatee County, Florida, were conducted from February 1979 to February 1980. Habitat preference, distribution, and morphology are reported herein for nine species and one variety of *Vaucheria* de Candolle. Five taxa—*V. arcassionensis*, *V. aversa*, *V. coronata*, *V. prolifera* var. *reticulospora*, and *V. pseudogeminata*—are first reports for the Gulf of Mexico coastal region. *Vaucheria velutina* (= *V. thuretii*), the most abundant taxon identified in the region, is common in diverse habitats. *Vaucheria prolifera* var. *reticulospora* is reported for the first time in North America from coastal Mississippi.

### INTRODUCTION

Recent investigations of algae from coastal regions of the Gulf of Mexico indicate that species of *Vaucheria* de Candolle are abundant throughout the winter months (Pecora 1976, 1977, 1978). These studies reveal a diverse but seasonal assemblage of *Vaucheria* species in the region. Other investigations, including those of Humm and Caylor (1957), Humm and Taylor (1961), Humm and Hamm (1976), and Gallagher and Humm (1980), also report species of *Vaucheria* from diverse habitats within the region. This report is based on 1979 and 1980 field and laboratory studies of species of *Vaucheria* in the coastal region of the Gulf of Mexico from Cameron Parish, Louisiana, to Coquina Beach, Manatee County, Florida. Identification of *Vaucheria* species was enhanced in subsequent laboratory studies since oogonia and antheridia are normally produced when algal filaments lacking sex cells are incubated under controlled environmental conditions in the laboratory. Nine species and one variety of *Vaucheria* are reported herein, of which *V. arcassionensis*, *V. aversa*, *V. coronata*, *V. prolifera* var. *reticulospora*, and *V. pseudogeminata* are new to the Gulf of Mexico region. *V. adela* is newly reported from Louisiana, and *V. erythrospora* is newly reported from Florida. I report herein the recently proposed *V. prolifera* var. *reticulospora* (Rieth 1978) for the first time in North America from Hancock County, Mississippi.

### MATERIALS AND METHODS

Samples of algal mats were taken from various sites along the Gulf of Mexico from southwestern Louisiana to central Florida. Salinities were measured with an American Optical refractometer. Procedures for collection, maintenance of algal material, and documentation are as reported previously (Pecora 1976, 1977).

### OBSERVATIONS AND DISCUSSION

Taxa are arranged alphabetically. Names preceded by an asterisk have not been reported previously from the Gulf of

Mexico region. Size, temperature, and salinity determinations not indicating a range of variation are means.

#### *Vaucheria adela* Ott and Hommersand 1974 (Figure 1)

Filaments to 35  $\mu\text{m}$  in diameter, branched; monoecious; androphores terminal; antheridia pedicellate, hooked or coiled, lanceolate, with a single terminal pore, one to several per androphore; oogonia solitary on filaments, subsessile, oval to obliquely ovoid, with a small distal vertical beak; oospores almost filling the oogonium, bearing a reddish-brown spot at maturity.

*V. adela* was collected on March 13, 1979, on moist soil of a *Spartina patens* (Ait.) Mull. marsh along Louisiana Route 1, Lafourche Parish. It was a component of large algal mats (ca 0.3 to 1.2  $\text{m}^2$ ) in open, nonshaded areas of the marsh. The temperature of standing water was 21°C, and the salinity averaged 6.0 ppt. Sexual cells were observed when collected and filaments of *V. erythrospora*, *V. repens*, and *V. velutina* were identified after portions of algal mats were incubated in the laboratory for four days. The Louisiana plants are similar in size and morphology to those collected at the type locality in North Carolina (Ott and Hommersand 1974), and from a *Juncus roemerianus* Scheele marsh on Marsh Island in St. Louis Bay, Mississippi (Pecora 1978). This is the first report of *V. adela* from Louisiana, and the second of this alga in North America exclusive of the type locality.

#### \**Vaucheria arcassionensis* Dangeard 1939 (Figure 2)

Filaments 58 to 94  $\mu\text{m}$  in diameter, branched; monoecious, sex cells usually borne in bisexual pairs, antheridia occasionally not adjacent to an oogonium, antheridia, pedicellate, 29 to 36 x 60 to 120  $\mu\text{m}$ , tubular coiled, with one terminal pore; oogonia 79 to 108 x 108 to 161  $\mu\text{m}$ , frequently on a short pedicel, rarely sessile, ovoid; oospores elliptical-ovate, filling most of the oogonium, with a thick (4.8  $\mu\text{m}$ ) wall.

*V. arcassionensis* was collected on December 17, 1979, on soil of a *Juncus roemerianus* marsh at Live Oak Point, St. Marks State Park, Wakulla County, Florida. It occurred in exposed areas at the edge of the marsh, and was mixed

with filaments of *Cladophora* sp. and *Dichotomosiphon tuberosus* (A.Br.) Ernst. The salinity and temperature of soil water were 25 ppt and 14°C, respectively. Filaments were sterile when collected but produced mature sex cells after 9 days of incubation in the laboratory.

*V. arcassionensis* was described from France (Dangeard 1939), and has subsequently been identified in the United States from New England (Taylor 1937, Blum and Conover 1953, Webber 1968), and from North Carolina (Ott and Hommersand 1974). This was the most abundant species of *Vaucheria* identified from coastal North Carolina (Ott and Hommersand 1974); however, my studies conducted largely since 1974, indicate that *V. velutina* (thuretii) is the most abundant *Vaucheria* species in the Gulf of Mexico region. This first report of *V. arcassionensis* in the Gulf of Mexico region extends its recorded range from North Carolina to Florida.

**\**Vaucheria aversa* Hassall 1843 (Figure 3)**

Filaments 41 to 96  $\mu$ m in diameter; monoecious; oogonia single or in short series, 82 to 113  $\times$  96 to 132  $\mu$ m, subspherical with a deflexed beak which contains a large (16.2  $\mu$ m) pore; oospores spherical to ovoid, 87  $\mu$ m in diameter, not filling the oogonium; antheridia, 22 to 36  $\times$  48 to 84  $\mu$ m, sessile or borne on a short pedicel, cylindrical, tapering slightly to a single terminal pore which is directed toward an oogonium.

*V. aversa* was collected on February 17, 1979, on moist soil from a freshwater marsh adjacent to Little Bayou, Vermilion Parish, Louisiana, and on January 26, 1980, on hummocks in a freshwater marsh in Buccaneer State Park, Hancock County, Mississippi. In both locations *V. aversa* was found with other common freshwater algae such as *Spirogyra* sp. and *V. racemosa*. Plants collected at both locations contained only the subspherical oogonia; the erect or oblique short-fusiform oogonia (Blum 1972) were not observed. *V. aversa* has been reported in freshwater areas of the eastern and midwestern United States (Collins 1928, Koch 1951, Blum 1972), and is widely distributed outside of North America. This report of *V. aversa* is the first for both Louisiana and Mississippi, as well as for the Gulf of Mexico coastal region.

**\**Vaucheria coronata* Nordstedt 1879 (Figure 4)**

Vegetative filaments 46 to 62  $\mu$ m in diameter; monoecious, bisexual pairs of sex cells on short (43 to 97  $\mu$ m) branches or oogonia and antheridia on separate short branches; oogonia ovoid, 82 to 105  $\times$  87 to 158  $\mu$ m, opening by several tubular papillae forming a corona; oospores spherical, 104  $\mu$ m in diameter, not filling the oogonium, with a prominent central red spot when mature; antheridia containing a lateral discharge pore 36 to 46  $\times$  48 to 65  $\mu$ m, cylindric, separated from the branch by a small empty space, occasionally two antheridia on a single fruiting branch.

*V. coronata* was collected on February 28, 1979, on soil

of a recently burned *Spartina patens* marsh along Louisiana Route 57, Terrebonne Parish, Louisiana. It occurred in small bright-green algal mats in open areas along with *V. dillwynii*, *V. erythrospora*, and *V. synandra*. Although sexual when collected, filaments of *V. coronata* contained neither intercalary antheridia nor akinetes (Simons 1974). The salinity and temperature of standing water at the collection site were 3.0 ppt and 17°C, respectively.

*V. coronata* is a commonly reported alga from salt marshes in northern Europe. Nienhuis and Simons (1971), DeJonge (1976), and Wilkinson (1975) all report *V. coronata* as common in coastal areas. However, in the United States, the recorded distribution of this alga was limited previously to the eastern Atlantic coast (Collins 1928, Blum and Conover 1953, Ott and Hommersand 1974, Bird et al. 1976). I report herein *V. coronata* for the first time from Louisiana, and from the Gulf of Mexico coastal region.

***Vaucheria erythrospora* Christensen 1956 (Figure 5)**

Filaments 26 to 43  $\mu$ m in diameter; monoecious; antheridia 19  $\mu$ m in diameter on short pedicels, coiled, circinate, with a single terminal pore; oogonia at the end of a lateral branch (to 600  $\mu$ m), solitary, 58 to 72  $\times$  67 to 82  $\mu$ m, ovoid to reniform, dehiscent, with a prominent beak; oospore not filling the oogonium, with a red-brown wall and a reddish central spot when mature.

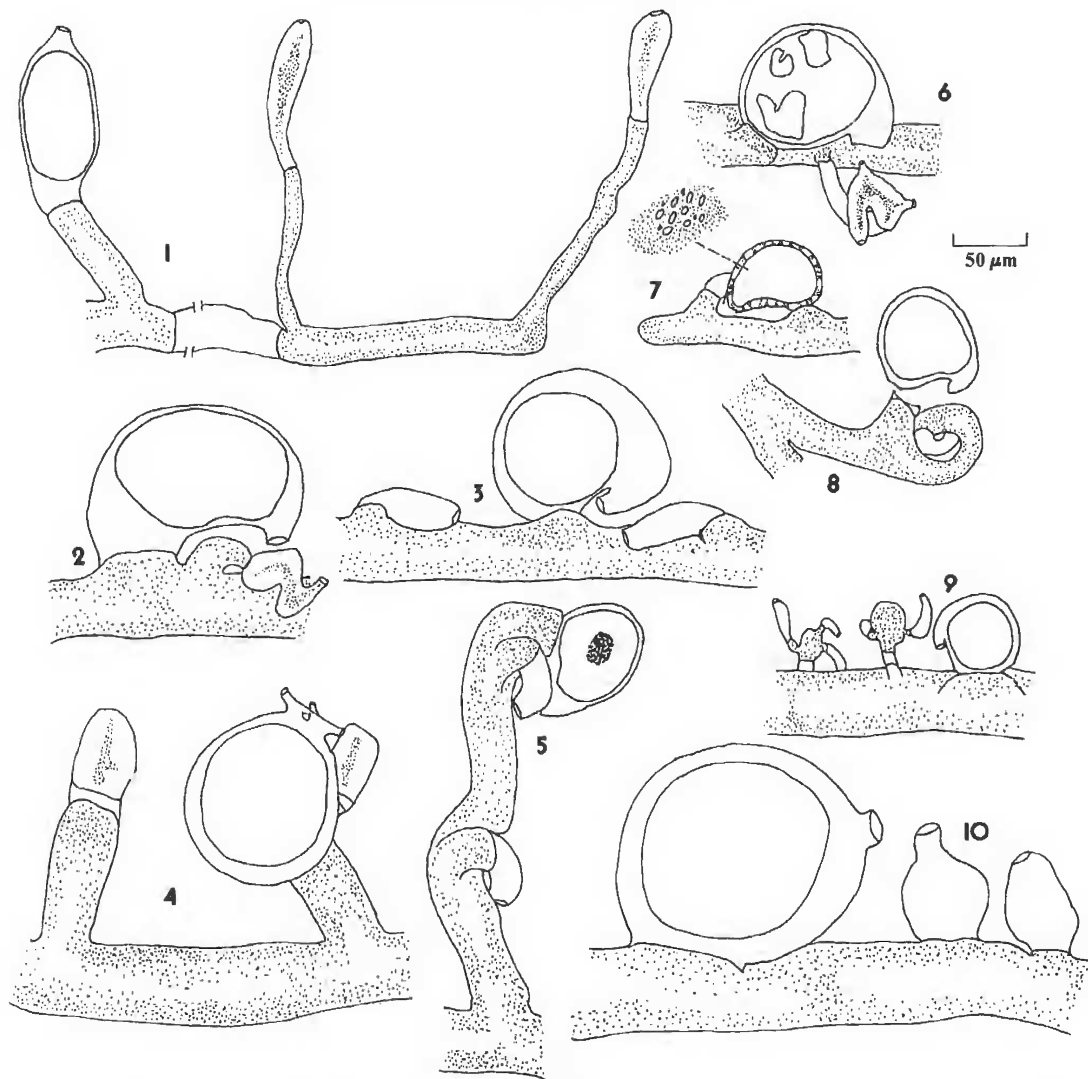
*V. erythrospora* was collected on December 16, 1979, on sand in a field of the grass *Dactyloctenium aegyptium* (L.) Beauv. at Coquina Beach, Manatee County, Florida. Plants were sexual when collected. I have collected *V. erythrospora* from various locations and habitats in Louisiana and Texas where the salinity ranged from 1.0 to 25.0 ppt (Pecora 1977). This first report of *V. erythrospora* in Florida extends its range from Louisiana in the Gulf of Mexico coastal region. Prior to my 1977 report, the southern limit of the distribution of *V. erythrospora* was in North Carolina (Ott and Hommersand 1974).

***Vaucheria nasuta* Taylor and Bernatowicz 1952 (Figure 6)**

Filaments to 51  $\mu$ m in diameter; monoecious; antheridia, usually associated with an oogonium, one to several, separated from the filament by short empty cells, tubular, curved, with a terminal and one to several lateral pores; oogonia sessile, with a large deflexed beak; oospores spherical, containing plate-like lipid bodies, almost filling the oogonium.

*V. nasuta* was collected on March 13, 1979, on dry soil from open areas of a *Spartina patens* and *Salicornia* sp. marsh adjacent to Louisiana Route 1, Lafourche Parish, Louisiana. Small (ca 10 cm<sup>2</sup>) mats of *Vaucheria* species were confined to elevated dry areas of the marsh. Plants were not sexual when collected but produced abundant sex cells after 12 days of incubation in the laboratory.

This species is well known in the United States (see Pecora 1978). Along the Gulf coast, this alga was reported from the



Figures 1–10. *Vaucheria* species from the Gulf of Mexico. Bar represents 50  $\mu$ m. 1. *V. adela*—Androphore with two antheridia and a portion of a filament with an oogonium. 2. *V. arcassionensis*—Filament bearing an oogonium and antheridium. 3. *V. aversa*—Filament bearing an oogonium and two antheridia. 4. *V. coronata*—Filament bearing an oogonium and two antheridia. 5. *V. erythrospora*—Bisexual fruiting branch. 6. *V. nasuta*—Filament bearing an oogonium and antheridium. 7. *V. prolifera* var. *reticulospora*—Filament bearing an oogonium and antheridium. 8. *V. pseudogeminata*—Bisexual fruiting branch with a dehiscent oogonium. 9. *V. synandra*—Filament bearing an oogonium and two androphores each bearing antheridia. 10. *V. velutina*—Filament bearing an oogonium and two antheridia.

Calcasieu River, Louisiana (Kapraun 1974), and from a *Spartina patens* marsh along the Aransas River, Texas (Pecora 1978). I have identified several other possible collections of *V. nasuta* which did not develop diagnostic features adequate for positive identification. The infrequent reports of this taxon may result from its brief occurrence in the sexual condition.

\**Vaucheria prolifera* Dangeard var. *reticulospora* Rieth 1978 (Figure 7)

Vegetative filaments 24 to 41  $\mu$ m in diameter; monocious, sex cells in bisexual pairs; oogonia 41 to 48  $\times$  58 to 91  $\mu$ m, subterminal, sessile, ovoid; antheridia terminal, saccate, to 35  $\mu$ m in length; oospore filling the oogonium

except for the beak, with a prominent central red-brown spot and reticulate outer wall.

This *Vaucheria* species was collected on January 26, 1980, on compacted plant debris at the edge of a *Juncus roemerianus* marsh, Buccaneer State Park, Hancock County, Mississippi. The site, at the time of collection, was dry and contained many small (ca 5 to 9 cm<sup>2</sup>), bright-green algal mats. Temperature of standing water in the adjacent marsh was 15°C, and the water had a salinity of 9.5 ppt. Algal mats grew at elevations above the normal high water level of the adjacent marsh. The freshwater species *V. racemosa* and several species of desmids also were identified from the same location.

Since my 1977 report of *V. prolifera* var. *prolifera* from a *Phragmites communis* Trin. marsh, I have identified the typical form of this alga from several locations in Louisiana during the winter months of 1978 and 1979. These collections were made from freshwater and from low-salinity (4.0 ppt) habitats. *V. prolifera* var. *reticulospora* was proposed by Rieth in 1978 to include plants with reticulate-foveate oospore walls. The Mississippi plants compare favorably in dimension and morphology to those at the type location except that the oogonia of the Mississippi plants were smaller and neither aplanospores nor aplanosporangia were observed. I report herein the first collection of *V. prolifera* var. *reticulospora* from a site other than the type location in the Harz Mountains, Germany.

**\**Vaucheria pseudogeminata* Dangeard 1939 (Figure 8)**

Vegetative filaments 26 to 41 µm in diameter; monoecious, sex cells in bisexual pairs on pedicels to 460 µm long; antheridia 14 to 19 × 36 to 48 µm, circinate, partially coiled; oogonia 63 to 74 × 72 to 96 µm, one per branch, reniform, with a conical beak, 21 µm at its base and tapering to a 10-µm pore; oospores filling the oogonia except for beak, with a central red spot and a thick wall when mature.

*V. pseudogeminata* was collected on December 28, 1978, January 25, February 23 and March 20, 1979, from the exposed walls of a branch channel of the Intracoastal Canal at Louisiana Route 318, St. Mary Parish, Louisiana; on March 29, 1979, on well-shaded soil at the base of black mangrove (*Avicennia germinans* [L.] L.), Bayou Fouchon, with a salinity of 27.0 ppt; and on January 26, 1980, from hummocks in a freshwater marsh area of Buccaneer State Park, Hancock County, Mississippi.

*V. pseudogeminata* occurred in small, bright-green felt-like patches (ca 2 to 12 cm<sup>2</sup>). It was associated with *V. prolifera* var. *prolifera* at the Intracoastal Canal site, and with *V. erythrospora*, *V. nasuta*, and *V. synandra* at Bayou Fouchon. *V. aversa* and freshwater racemose species of *Vaucheria* were identified in collections made at Buccaneer State Park. Although the water at Bayou Fouchon had a salinity of 26.0 to 27.0 ppt, *V. pseudogeminata* grew at an elevation that normally would be out of the tidal influence except in times of extremely high water. Similarly at the

Intracoastal Canal, this species of *Vaucheria* grew at 1.0 to 1.3 m above the normal high-water mark.

This alga is commonly reported in Europe (e.g., Christensen 1969, Simons 1974, Rieth 1975); and in the United States, it is known from a California salt marsh (Blum 1971) and from Florida (Blum 1953). These are the first reports of *V. pseudogeminata* from Mississippi and Louisiana.

***Vaucheria synandra* Woronin 1869 (Figure 9)**

Filaments 65 to 94 µm in diameter, branched; monoecious; androphores, 57 × 91 µm, attached to the filament by a small empty cell; antheridia, one to several, hooked, sessile on the androphore, opening by a terminal pore; oogonia 91 to 132 × 113 to 156 µm, solitary, sessile, with a conspicuous beak; oospore, oval, filling the oogonium except for the beak, wall punctate.

*V. synandra* was collected on February 28, 1979, from a recently burned *Spartina patens* marsh adjacent to Louisiana Route 57, Terrebonne Parish, Louisiana; and on March 13, 1979, on soil at the base of black mangrove along Bayou Fouchon, Lafourche Parish, Louisiana. The salinity and temperature at the Terrebonne site were 2.0 to 3.0 ppt and 17°C, respectively, whereas values of 26.0 to 27.0 ppt and 20°C, respectively, were recorded at Bayou Fouchon. *V. minuta*?, *V. nasuta*, and *V. pseudogeminata* were identified in soil samples from Lafourche Parish, and *V. dillwynii*, *V. erythrospora*, and *V. coronata* were identified from Terrebonne Parish.

This is the first report of *V. synandra* in the United States since my 1976 report, which added this taxon to the North American algal flora. The present study indicates that *V. synandra* is characteristic of low-salinity habitats as well as habitats that are frequently flooded with brackish water.

***Vaucheria velutina* C. Agardh 1824 (*V. thuretii* Woronin 1869) (Figure 10)**

Vegetative filaments to 71 µm in diameter; monoecious; oogonia single or in pairs, sessile, obovoid, antheridia, one to several, erect, sessile on the filament in the vicinity of the oogonia; oospore not filling the oogonium, subspherical.

*V. velutina*, the earlier legitimate name for *V. thuretii* (Christensen 1973), the most common species of *Vaucheria* in the Gulf of Mexico coastal area, was collected seven times from February 28, 1979, to February 10, 1980. In Louisiana, *V. velutina* was identified on February 28, 1979 on mud in open areas of a *Juncus roemerianus* marsh adjacent to Petite Caillou Bayou, Terrebonne Parish, where the salinity ranged from 4.0 to 9.0 ppt; on March 13, 1979, from compacted sand at the edge of a tidal pool ca 15 m from the beach, Lafourche Parish, where the salinity was 27.0 ppt; on March 13, 1979, from an exposed mud flat in a *Juncus roemerianus* marsh at the Leeville Bridge, Lafourche Parish, with a salinity of 14.0 ppt; and on February 10, 1980, on extensive mud flats at Josephs Harbor, Cameron Parish, with a salinity of 6.5 ppt. In Hancock County, Mississippi, this alga

was collected on January 26, 1980, in exposed mud of a *Spartina patens* marsh on Mississippi Sound adjacent to Buccaneer State Park with a salinity of 2.0 ppt; on January 26, 1980, in mud of a *Juncus roemerianus* marsh near Buccaneer State Park with a salinity of 9.0 ppt; and on January 26, 1980, from dry soil of a recently burned *Juncus roemerianus* and *Distichlis spicata* (L.) Green marsh along Bayside Drive, adjacent to Mississippi Sound.

This report of *V. velutina* from Louisiana and Mississippi supports my recent report (1977) that *V. velutina* (thuretii) is the most abundant *Vaucheria* species in the northern Gulf coast region. Plants from four collections were sexual when collected, and plants from three collections produced sex cells after 4 to 14 days incubation in the laboratory. The presence of sex cells in field material could not be correlated to either salinity, which ranged from 2.0 to 27.0 ppt, or water temperature, which ranged from 9 to 24°C. All my collections of *V. velutina* from 1976 to the present were made from December to April. Subsequent incubation of sterile filaments collected during other months failed to produce sexual filaments of *V. velutina*. Along the northeastern Atlantic United States and Canadian coasts, *V. velutina* was identified each month except February (Blum 1971). Similarly Ralph (1977) identified *V. velutina* from salt

marshes, pannes, and pools from June to October in coastal Delaware. Elsewhere in the United States, *V. arcassienensis* was the dominant species of *Vaucheria* in North Carolina (Ott and Hommersand 1974), while *V. litorea* was dominant in the winter and spring in Nova Scotia (Bird et al. 1976).

In the Netherlands, *V. velutina* is often the dominant species of *Vaucheria* during the summer months in brackish-water habitats (Simons and Vroman 1973, Nienhuis and Simons 1971, Simons 1975). Extensive mats were formed as the result of prolific aplanospore production (Nienhuis and Simons 1971, Simons 1975). In the cooler months from approximately November to April, *V. arcassienensis* (Simons and Vroman 1973), *V. intermedia* and *V. coronata* (Nienhuis and Simons 1971), and *V. subsimplex* (Simons 1975) were the dominant or subdominant species of *Vaucheria* identified.

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